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WORLD NATURAL RESOURCES[1]

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INTRODUCTION

It will, I think, be obvious that a subject as broad as that assigned to me to-night can not be fully treated in the time at my disposal. I therefore propose in the first place to review, very briefly, the fundamental resources that nature has placed at man's disposal; subsequently I shall discuss, at somewhat greater length, the adequacy or inadequacy of those resources to provide the requisites for food, clothing, shelter, heat and power.

It will not be sufficient, however, to consider the world's natural resources from the point of view of present methods of utilization alone. Resources in which we were not interested yesterday are of vital importance to-day; the useless or inert of to-day may to-morrow, through the contributions of science, profoundly affect the welfare of the human race.

To take only one example of how science and technology have made available a natural resource that probably would not even have been listed as such fifty years ago, let us consider the nitrogen of the atmosphere. Our knowledge of nitrogen as a plant and animal food goes back only about one hundred years. Research during the latter part of the nineteenth century demonstrated that the ultimate source of nitrogen was the air, from which it was derived through the action of micro-organisms in the soil, and atmospheric electricity. These, however, were natural agencies, over which man had little control, and in order to restore the depleted nitrogen of the soil he was dependent upon the application of animal wastes, nitrates obtained from certain natural deposits, and ammonia recovered as a by-product in the cooking of

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coal. Although such supplies were of a substantial character, they were recognized as insufficient for the ever-increasing population of the world, and the problem of obtaining an adequate source of nitrogen was the cause of much concern.

Then came, in the first fifteen years of the present century, the development of the electric arc, the calcium cyanamide and the ammonia processes of nitrogen fixation, as a result of which nitrogen in cheap and convenient form became available in any quantity desired. This removed, for all time to come, the possibility of a world shortage.

This is but one illustration of the rôle of science in finding a complete solution to one of the major problems of food supply. Since at no period in the world's history has science been so active as it is to-day, I believe we may rest assured that where the fundamental resources exist in nature, man will eventually find the means for their utilization.

Fundamental Resources

In the ultimate analysis, we are dependent upon the abundance and availability of the different chemical elements in the world's crust, the ocean and the atmosphere. It will therefore be of interest to examine the magnitude of our natural resources as they exist in these major reserves.

TABLE 1

Estimated Composition of the Earth's Crust

Metals				Non-metals	
	Per cent.		Per cent.		Per cent.
Aluminum	7.96	Nickel	0.023	Oxygen	47.77
Iron	4.44	Strontium	0.02	Silicon	27.25
Calcium	3.51	Chromium	0.01	Hydrogen	0.22
Potassium	2.48	Copper	0.0075	Carbon	0.19
Sodium	2.47	Zinc	0.0040	Phosphorus	0.10
Magnesium	2.28	Lead	0.0020	Sulfur	0.10
Titanium	0.47	Silver	0.00001	Fluorine	0.10
Manganese	0.09	Gold	0.0000005	Chlorine	0.01
Barium	0.08	Others	0.20	Others	0.21
			24.05		75.95

Table 1 lists separately the principal metals and non-metals in the order of their abundance in the crust of the earth. It will be observed that the most common metal is not, as one might suppose, iron, but aluminum, which constitutes approximately one thirteenth of the earth's crust, as against one twenty-second for iron. These metals, as well as calcium, potassium, sodium and magnesium, exist in such enormous quantities that we need never fear that a shortage will develop. It is interesting to observe that the so-called "common" or "base" metals, copper, zinc and lead, are present to the extent of less than 0.01 per cent. each. Fortunately, nature has so concentrated them, and man has so thoroughly worked out their metallurgy, that they are cheaply available to the present generation. Their future, however, is somewhat obscure, for the known commercial deposits of these metals will nearly all be exhausted in the next 100 years, and most of them in less than half that time. No doubt other deposits will be discovered, particularly as the world's geology becomes more thoroughly worked out and scientific methods of prospecting for ore deposits are further developed. It may be expected, however, that sooner or later recourse will be had to deposits of lower grade, not now considered as ore, also to the increasing use of scrap metal and to the partial substitution of the commoner metals for those that are approaching exhaustion. In this connection, the enormous increase in the output of metallic aluminum during the past three or four decades is significant, as is also the still more recent commercial production of magnesium at relatively low cost.

Looking at the list of non-metals, some may be surprised to observe that oxygen and silicon together make up no less than 75 per cent. by weight of the earth's crust, in which, however, both of these elements exist only in combination. All the other non-metals listed also exist in quantity sufficient for both present and future needs. Even chlorine, given as 0.01 per cent., constitutes 60 per cent. by weight of common salt, of which there is no scarcity. Before we leave this subject, it should be noted that potassium and phosphorus, the bases of essential plant foods, are to be classed with the abundant elements.

Table 2 gives the quantities of the principal elements in solution in sea water, expressed as tons per cubic mile. Since sea water is at the door of virtually every country in the world, none of them need fear a shortage of these elements.

Last summer in California I visited the first commercial plant to recover magnesia from sea water; several others are now under construction or contemplated. Bromine, though relatively scarce, is recovered to the extent of about 15,000 tons per year in two commercial plants—approximately the quantity contained in one twentieth of a cubic mile of sea water. Even iodine, though present to the extent of only one part in 23,000,000 of sea water, amounts to 200 tons per cubic mile, and since the ocean is estimated to contain 300,000,000 cubic miles, the total quantity available in this natural reserve is no less than 60,000,000,000 tons.

The third main reserve of the elements is the atmosphere, the composition of which is shown in Table 3. Quantities are given in tons per square mile, and since there are about 200,000,000 square miles of the earth's surface, it is obvious that a nitrogen famine is not imminent! It is reassuring to find so much carbon dioxide, upon which all plant life depends; this is of course being returned to the atmosphere, through the oxidation of carbon, at substantially the rate of ab-

TABLE 2

Elemental Reserves in the Ocean

	Tons per cubic mile
Chlorine	90,000,000
Sodium	53,000,000
Magnesium	5,700,000
Sulfur	4,300,000
Potassium	3,300,000
Calcium	2,400,000
Bromine	310,000
Iodine	200

sorption by vegetation. The ocean, which dissolves carbon dioxide, and the atmosphere, in which it exists as a gas, together constitute a giant balance wheel, which takes up any variations in the natural cycle of plant growth and decay. The rare gases in the atmosphere are of more than passing interest, since these are already finding some practical applications, as, for example, in neon signs.

TABLE 3

Gaseous Reserves in the Atmosphere

	Percentage by weight	Tons per square mile at sea level
Nitrogen	75.474	22,269,000
Oxygen	23.200	6,845,400
Argon	1.283	378,600
Carbon dioxide	.040	11,800
Neon	.00125	370
Hydrogen	.00070	207
Krypton	.00029	86
Helium	.00007	20
Xenon	.00004	12

Food

Just 140 years ago Malthus published his first essay dealing with what he believed to be a tendency for the world's population to increase faster than the means of subsistence. His ideas were widely accepted, and in the years that followed there were many who envisaged a time, in the not very distant future, when the world's population would increase to such an extent that an acute shortage of food would develop.

Let us look for a moment at the situation in the time of Malthus. Plant food was known to exist in the soil, but this quickly became depleted by continuous cropping. What could be more logical than to conclude that when all the cultivable land had been occupied the peak of food production would have been reached, and as further crops were removed the productivity of the soil would decrease?

One can scarcely blame Malthus and his followers for not being able to predict the solution of the immediate problem through the contribution which science would make to society. Since Malthus's time, potash has become available from the Stassfurt and other great deposits of potassium salts; soluble phosphates have been manufactured by treating natural rock with sulfuric acid or by appropriate furnace methods; nitrogen has been obtained from the various sources already mentioned. As a result, conditions have been completely changed in spite of the rapidly increasing world population.

As yet, only a beginning has been made in increasing food production. Every one familiar with scientific agriculture knows that a major increase in crop growth could be brought about, on the present acreage, by the more liberal application of potash, phosphoric acid and nitrogen and by the neutralization of natural acids. The elements iron, calcium, sodium, magnesium, manganese, zinc, copper, cobalt, sulfur, chlorine, iodine and boron are now all recognized as plant foods, or animal foods derived from plants, yet very little has been done towards determining the requirements of soils with respect to these elements and making the necessary additions. There can be little doubt that human and animal food supplies could be doubled or tripled if all necessary plant foods were applied in abundance.

Malthus believed, and it has often been stated even in recent years, that the soil is the world's most valuable natural resource. Actually, in view of the ease with which ordinary soil is depleted, we should regard it rather as a convenient medium through which nutrient can be made available to plants. As such it is of inestimable value, but Gericke has recently demonstrated in California that soil is not essential, for he has developed the new art of "hydroponics," or the growing of crops in nutrient solution without soil. It is of interest to note that tiny Wake Island in the Pacific, only half an acre in extent, is the newest hydroponic farm, and that crops will be grown there for the passengers and crews of transpacific Clipper planes. May this not be a picture of the intensive farming of the future, if the world's population should increase to the point where the cultivable areas of the earth's surface are too limited in extent?

The progress of the plant breeder has been another major factor in deferring the time of distress predicted by Malthus. The development of early-ripening varieties of wheat, for example, has pushed well to the north the zone in which this most important cereal can be grown, a zone, be it noted, extending around the world where land areas are greatest. An equal triumph has been scored in the breeding of rust-resistant varieties of wheat, now for the first time available in large quantity. In 1935 the loss from rust in western Canada alone was officially estimated at fully 100,000,000 bushels of wheat, and on the average the loss would amount to at least 25 or 30 millions annually. Within five years the losses from wheat rust should be substantially eliminated from all countries of the world.

Recently research has been organized on the destruction of weeds, the losses from which in the United

States have been estimated to amount to more than those from insects and all plant and animal diseases combined. Improved cultural practices have already been evolved, chemicals have been found that will destroy undesirable vegetation, and even some that will selectively kill certain annual weeds and leave cereal crops substantially undamaged.

The advances in plant and animal pathology have been scarcely less remarkable than those in breeding. One need only mention a few—the chemical disinfection of seed grain and potatoes, the control of hog cholera, the reduction of tuberculosis in cattle—to realize the importance of these developments. Further, there is a growing recognition of the fact that a number of plant and animal diseases are not caused by any specific organism, but are the result of deficiencies in food supply. For example, the application of a small amount of boron to soil prevents drought spot and corky core of apples and alfalfa yellows; the administration of a minute trace of cobalt prevents a serious deficiency disease of sheep.

I would remind you, too, that our food supplies are not derived entirely from land areas, but also from water areas, which constitute some 75 per cent. of the total surface of the earth. The world production of fish now amounts to nearly 15,000,000 tons per year, or about 15 pounds per person. Japan alone has over 1,000,000 persons employed in fishing.

The subject of food resources would be incomplete without mention of what, if it eventuates, may prove to be an accomplishment of the most far-reaching importance. Chemists have already synthesized thousands upon thousands of complex compounds; if they are successful in commercially synthesizing carbohydrates for human and animal food, they will have achieved their greatest triumph, and that is a feat the possibility of which can not be lightly dismissed.

Clothing

Probably the earliest type of clothing worn by mankind consisted of the skins of animals, and one can almost picture the Malthusians of that day predicting the time when the world's population should have increased to such an extent that insufficient furs and skins could be obtained. As a matter of fact, that period would have arrived relatively soon, but for the existence of plant and animal fibers and the development of the art of weaving. By that technological advance a clothing shortage was indefinitely postponed.

But what of the future? If the world's population is doubled or tripled, will there be sufficient raw materials to provide clothing for all? Let us consider our present resources.

Cotton is by far the most important textile fiber, its annual production being about three times as much as that of all others combined. Without examining in detail the production of the major cotton-growing countries we may note that the United States grows just about half of the world's production, and this on 30 or 40 million acres, or say 2 per cent. of the total land area of that country. If the demand were to arise, cotton could be produced sufficient for three or four times as great a world population as that of the present, without making any serious inroads on the areas required for food production.

A similar situation exists in regard to wool. The single island of Australia now produces 25 per cent. of the world's wool, and could produce on an even larger scale. Great Britain and New Zealand both have an average of more than 200 sheep per square mile; Canada has only one! I would not wish to imply that all countries could equal the record of these two, but in Canada, for example, at least a tenfold increase in sheep population would seem quite feasible.

But we are no longer dependent upon natural fibers, for in the last 25 years the problem of the commercial production of synthetic fibers has been solved, and a great new industry has sprung up. In 1920, for the first time, the production of rayon in the United States exceeded 10,000,000 pounds; in 1937, it was more than 300,000,000. The world production in 1936 was 1,303,165,000 pounds, yet this is one of the newest industries. Thus, through developments in science and technology, an entirely new resource for the manufacture of textiles has been provided, one sufficient to clothe untold millions of people.

But rayon is not to be permitted to monopolize the field of synthetic fibers. For several years a so-called "artificial wool" has been made in Italy from casein, a product of skim milk. Now reports come from Japan that a similar fiber has been made there from soybean protein. While the present product appears to be definitely inferior to natural wool, it must be remembered that the first rayon was so weak as to give rise to the prediction that no large market for it would ever be developed.

Shelter

The problem of shelter has been a live one since the earliest days of the human race. Primitive man took refuge in caves to protect himself from the cold, the rain and the attacks of wild beasts, but the number of suitable caves was very limited, and history bears mute record that competition for them was keen. Doubtless man, with his rude weapons, frequently came off second best in the conflict which took place for their possession.

With the development of the simplest wood-working tools forests became the major source of raw material for the provision of shelter. For thousands

of years this invaluable resource has been used as lavishly as if it were inexhaustible, and indeed this is even to-day the situation in many countries. In Canada, for example, the forests are being destroyed—by man, insects and fires—some two-and-a-half times as fast as they are grown. The United States, although possessing not more than 10 per cent. of the total forest stand, is responsible for approximately 40 per cent. of the world's cut.

Nevertheless, the situation is not by any means hopeless. There are still vast forest areas, estimated to be as much as the area of the whole of North America plus Australia. The approximate distribution of this area is shown in Table 4, from which it will be evident that about two thirds of the total is in the possession of four of the world's political units, the U.S.S.R., the British Empire, Brazil and the United States. The Scandinavian countries and some others with relatively small area have had the foresight to institute scientific forest management, under which the forests are placed on a permanent basis and made to yield an annual crop.

TABLE 4

WORLD'S FOREST RESOURCES

	Percentage of the world's forest area
U. S. S. R.	21.1
British Empire (40 per cent. Canadian)	21.0
Brazil	13.4
United States	9.1
France and dependencies	3.9
Argentina	3.5
Japan	1.2
Germany and Austria	0.5
Italy and Abyssinia	0.4

The world's annual growth of wood is about 38,000,000,000 cubic feet. If all forests of the world were properly protected and given reasonable care, it is estimated that they could produce annually 350,000,000,000 cubic feet. It is thus evident that an appreciation of the seriousness of the situation, coupled with the general application of scientific methods of forest protection and growth, would provide for the needs of a population much greater than that of to-day.

Man discovered at an early date that excellent shelter could be secured by using mineral raw materials. Rock could be built up into substantial walls; clay dried in the sun became hard, and in desert countries afforded sufficient protection against the elements. Burnt clay blocks, or brick, became cheaply available. Clay being one of the most abundant of all mineral reserves, the potential brick supply is unlimited.

Concrete has become one of the major building materials. Gypsum products are now being applied in a wide field. Further, new materials, such as glass blocks, stainless steel and enamelled iron, are being introduced, providing variety in appearance and a wide range of physical properties. Nor has nature apparently fixed any limit to the quantities of such materials that may be used for the provision of shelter.

HEAT AND POWER

The major present sources of heat and power are coal, oil, natural gas, wood, peat and the energy of falling water. The use of wood and water power date back to prehistoric times. Coal was possibly used in China 2,000 years ago, but its use in the western world did not begin on any considerable scale until the latter part of the thirteenth century. As late as 1306, Edward I of England compelled all except smiths to cease burning coal and revert to the use of wood.

Table 5 shows the coal reserves of the world, as compiled by the International Geological Congress of 1913. It should be explained that, in the compilation of these reserves, all countries were asked to include seams of economic value one foot or more in thickness and not more than 4,000 feet from the surface, and in addition coal in seams two feet or more in thickness and at depths between 4,000 and 6,000 feet. No allowance was made for mining losses, which are very heavy. The figures therefore should be taken as a very generous estimate of the minable coal of the world.

TABLE 5

COAL RESERVES OF THE WORLD

	Millions of metric tons
United States	3,838,657
British Empire	1,729,105
China	995,587
Germany and Austria (1913)	477,232
U.S.S.R.	173,879
France and dependencies	37,585
Japan	7,970
Italy	243
World total	7,397,553

The most striking thing about these figures is the uneven distribution of coal reserves throughout the world. More than half of the total is in the United States, and 73 per cent. is in North America. Canada's proportion is about 17.5 per cent., or three quarters of that of the British Empire. Nevertheless, the reserves in China, Germany, U.S.S.R. and France are so large that no concern need be felt for a long time to come regarding the exhaustion of those deposits. Considering the world as a single unit, it may be observed that the tonnage of coal is so large that at the maximum rate at which it has yet been mined it would last for about 5,000 years. Even if the minable coal be half that quantity and the rate of mining should substantially increase, it is obvious that the supply is adequate for many hundreds of years. If, on the other hand, we take a backward look, a period of 2,000 years carries us only to about the beginning of the Christian era,

and the world's coal reserves must be regarded as possibly exhaustible within a similar period.

The present production of oil and gas is derived chiefly from the United States, which is responsible for some 60 per cent. of the world's total, and uses a correspondingly large proportion.

I shall not attempt to show the world's reserves of petroleum or natural gas, because these are so difficult to estimate. Twenty-five years ago it was predicted by some authorities that the reserves of petroleum would be substantially exhausted by the present time. Yet, in spite of an enormous increase in consumption, the supply seems greater than ever. Vast areas remain virtually unexplored as sources of oil and gas. Nevertheless, the known reserves are being depleted at such a rate that one can not with much confidence predict a natural supply sufficient for more than 50 or 100 years.

Even though the present deposits of crude oil be exhausted, however, there need be no shortage of liquid fuel. In many parts of the world there are large deposits of oil shales, which, though not ordinarily minable at a profit under present conditions, constitute a large potential reserve of oil. In Alberta, there is an enormous deposit of tar sands, extending over thousands of square miles, and it is estimated to contain sufficient bitumen to supply the world with oil for centuries. Further, motor fuel can be readily produced by the hydrogenation of coal and cellulose, and both methyl and ethyl alcohol can be used in internal combustion engines. One need therefore feel no anxiety for a long time to come about the world's liquid fuel supplies.

Wood and peat are still available in large quantities as fuel. The former has already been discussed, but it may be pointed out that its use as fuel is decreasing in most countries, although over large areas it will long continue to be an important local fuel. Peat deposits are all of a shallow character, and, although of considerable importance as a domestic fuel reserve, peat is not likely to be used on a very large scale.

It is almost equally difficult to obtain reliable figures regarding the water power available throughout the world. One authority gives the total water power of the U.S.S.R. as 3,000,000 horsepower; another makes an estimate of 165,000,000 for Asiatic Russia alone. The total for the British Empire is about 68,000,000 horsepower, of which approximately half is in Canada. That of the United States is about 55,000,000, of Norway and Sweden 22,000,000. Many of the great waterfalls of the world are remote from industrial areas, as, for example, Victoria Falls in Central Africa, the available horsepower of which has been estimated at 35,000,000, or five times that of Niagara. The total available water power of the world at an average six-months' flow is probably not less than 400,000,000 horsepower and may be substantially more.

Water power has a great advantage over most of the resources so far discussed in that it is, ordinarily speaking, of a permanent character and therefore inexhaustible. Nevertheless, the utility of any waterfall depends largely upon the amount of its minimum flow, which, for maintenance at a high level, requires regulation. Regulation is accomplished to a large extent in nature through the existence of forest areas and limited drainage; man has a tendency to cut the forests and drain the land, thereby accentuating both the maximum and minimum flow. Care must therefore be taken to see that even this valuable resource is not destroyed.

Two sources of power that have not yet been drawn upon heavily are winds and tides. The total amount of wind power is enormous, and its distribution is world-wide. On the other hand, its utilization is relatively costly and the supply is intermittent. Winds may become an important source of power as coal and oil reserves approach exhaustion, particularly if the cost of the storage of power to provide for periods of calm weather can be reduced. The tides are also a potential source of much power, but conditions on most coasts are not favorable to their utilization.

All these resources of heat and power have been, or are being, derived indirectly from the radiant energy of the sun. To use the sun's energy directly has long been the dream of inventors the world over, and a number of them have been technically though not commercially successful. A new attempt is now to be made, this time on a more comprehensive scale, at the Massachusetts Institute of Technology. Physical and chemical methods are to be tried, and also a biological method through the speeding up of the growth of trees.

The total quantity of heat derived from the sun's rays is enormous. President Compton, of the Massachusetts Institute of Technology, illustrates this by pointing out that in the temperate zones, during the three months of greatest sunshine, each acre of land receives the heat equivalent of about 250 tons of good coal. From this it is evident that the proportion of the sun's heat normally utilized in the growing of vegetation must be extremely small.

The heat of the earth's interior has often been mentioned as a potential source of power, and steam escaping from the ground near active volcanoes is already being used on a small scale. In most parts of the earth's surface, however, the temperature increase with depth is so slow as to offer little encouragement for the utilization of the heat of the interior.

Reference has often been made in the literature to

the enormous stores of energy locked up in atoms, and attention has been called to the automatic decomposition of radium to form elements of lower atomic weight. Undoubtedly there exists within the atoms an exceedingly high concentration of potential energy, but doubt may be expressed as to the likelihood of its utilization. I believe it was the late Dr. Slosson who referred to this source of heat and suggested that if man were ever successful in developing it he would find it difficult to control. The success of his experiment, Slosson thought, would be announced to the universe at large by the appearance, in the place now occupied by the earth, of a new star.

Miscellaneous Materials

A vast assortment of raw materials is drawn upon to meet the requirements of industry, whose purpose it is to provide man with the necessities of life, to satisfy his craving for pleasure, and, be it said to his discredit, to give him those facilities used for the destruction of his fellows. I have already dealt with most of the necessary raw materials, and reference need be made here to only three—iron, rubber and paper.

It has been pointed out that of the metals iron is second in abundance only to aluminum. The ultimate availability of this metal is therefore sufficient permanently to provide for the needs of mankind. In view of the dominant position of iron amongst the metals it is worth considering the magnitude and distribution of the world's reserves.

The maximum world production of pig iron in any one year may be taken as 100,000,000 long tons, which was the figure for 1937. It is estimated that the positive iron ore reserves of North and South America could supply the world's requirements at this rate for 40 years, and the probable reserves are sufficient for an additional period of 320 years. For Europe the corresponding figures are 50 and 160 years.

Other countries also have large reserves, but none comparable with those given. The total positive and probable resources of the world are sufficient at the present rate of consumption for about 600 years. This is a highly satisfactory situation, especially in view of the fact that enormous tonnages of lower-grade material are known to exist, and the probability that other large deposits will be discovered.

Rubber grows wild in a number of tropical countries, but the major production is now derived from plantations, where rubber trees are grown in a systematic way. The peak of rubber production was reached in 1929, with 863,410 tons. This would require 10,000 square miles of rubber trees, an area small enough to indicate that production could be multiplied many times, if the demand should arise. Many countries, however, lack the climatic conditions necessary for growing rubber trees, and in order to reach national self-sufficiency have sought substitutes. In the past few years success has been attained in such efforts through the production of various types of synthetic rubber. In some respects synthetic rubber is superior to natural rubber, for example, in being very resistant to the action of petroleum products. In Russia its manufacture has already become a national industry.

The enormous increase in the use of paper in recent years has been a major factor in the rapid cutting of the world's forests. Up to the present, conifers have been by far the largest source of wood for the manufacture of paper. Recently, however, more attention has been paid to hard woods, and methods have now been developed in the United States for the utilization of southern pine. Straw and other natural fibers are available in vast quantities and can be used if required; it is largely a question of economics.

In the light of what has already been said about the world's forests, it may be concluded that at the present rate of paper consumption the supply of raw materials can be maintained indefinitely. If the upward trend of consumption should continue, price increases sufficient to curtail present wasteful practices in the use of paper may be expected.

Comments and Conclusions

Thanks largely to science and technology, food supplies are likely to be adequate for a world population at least three or four times that of to-day, provided, of course, that the problem of distribution, with which this paper does not attempt to deal, can be solved. Although the future of some of the base metals is obscure, the world as a whole need fear no shortage for an indefinite period of the raw materials for clothing, shelter, heat, power and the principal necessities and luxuries of life. In the case of certain natural resources that are definitely exhaustible, nature has made abundant provision of possible substitutes.

All this is true of the world as a single economic unit. Unfortunately, however, the world is made up of a large number of economic units, many of which are endeavoring to establish economic self-sufficiency. For them the prospect is very different. Complete economic self-sufficiency is impossible, and even the measure of self-sufficiency for which many of the great powers of to-day are striving can be attained only by a major sacrifice of the standards of living.

In order to illustrate the extreme mutual dependence of the nations I have brought together in Table 6 some of the facts disclosed in our study to-night, and certain others which there has been no time to discuss. In this table the number "1" is taken to represent sub-

TABLE 6
NATIONAL SELF-SUFFICIENCY IN MAJOR MINERALS

	Br. Emp.	U.S.A.	U.S. S.R.	France and Dep.	Germany	Italy	Japan
Coal	1*	1	1	1	1	2	2
Iron	1	1	1	1	2	3	3
Copper	1	1	2	3	3	3	2
Lead	1	1	3	3	1	2	3
Zinc	1	1	2	2	2	3	2
Nickel	1	3	3	2	3	3	3
Tin	2	3	3	3	3	3	3
Asbestos	1	3	1	3	3	3	3
Petroleum	3	1	1	3	3	3	3

* Numerical order represents decreasing abundance in relation to national requirements.

stantially complete self-sufficiency, "2" partial or temporary self-sufficiency, and "3" definite lack of self-sufficiency.

From this it is evident that not a single one of the seven great powers is completely self-sufficient in supplies of the major minerals. The British Empire and the United States are, without question, in the happiest position in this respect. The U.S.S.R. is, I think, in a better relative position than that indicated by the table, since so large a part of her vast area is virtually unprospected. The other nations are very dependent upon international trade in minerals.

Nature has been generous in providing for man an abundant supply of the things he most needs, and will continue to provide for him, even though his wants be still further increased. Individual nations, on the other hand, are laboring under serious handicaps, largely self-imposed, and are suffering severely as a consequence. Let us hope they may eventually realize that the highest standards of living for their people can be attained only through international cooperation and world peace.

OBITUARY

EARL BALDWIN McKINLEY

THE disappearance of the Hawaii Clipper at sea on July 29 with its crew and passengers was a vital loss to medical education and medical research, for a passenger on this ship was a man who at the age of forty-three had risen to prominence and leadership in these fields. It was a great loss as well to various scientific societies in whose development this man had played a significant role. Every organization with which this leader came in contact felt the impact of his personality and was carried to higher levels of accomplishment. He was a man of the highest ideals, absolutely fearless in adhering to them. Original and ingenious in his ideas, he excelled in all these activities as well as in his research, to which he was devoted. Inspired by Novy and Vaughan while a medical student at the University of Michigan, his activity in research never faltered throughout all the administrative and organization work which engaged his attention. With apparently many years ahead of him for further outstanding accomplishments, it was a tragedy to have him disappear from our midst at such an early age; yet there is the satisfaction that Earl Baldwin McKinley was lost in the line of duty, seeking new knowledge, pioneering as was his wont.

Dr. McKinley was a passenger on the Clipper with Fred Campbell Meier, of the Department of Agriculture, for the purpose of making studies in aerobiology. These workers had become interested in the question of the transmission of various bacteria and pollens through the upper atmosphere over the high seas. McKinley also intended to continue his leprosy studies at Manila while awaiting the return of the Hawaii Clipper from its hop to China, and had made detailed arrangements for the skin testing of 500 lepers.

McKinley was born in Emporia, Kansas, on September 28, 1894, the son of Joseph Baldwin McKinley and Mary Elizabeth (Griffith). He left Emporia to enter the University of Michigan in 1912 and received his A.B. degree at that institution. His formal education was interrupted by the world war and soon after graduation he entered the service. Before leaving for overseas he married on June 23, 1917, Leola Edna Royce, a classmate of his at the University of Michigan. He served in the front-line trenches as an intelligence officer, and at the close of the war returned to this country, serving for a short time in the Medical Corps. In 1919 he re-entered the University of Michigan for his medical studies and became an assistant of Professor Novy. He accepted in 1922 the post of assistant professor in pathology and bacteriology in the College of Medicine of Baylor University. The next year he was made professor of hygiene and bacteriology and chairman of the department.

While at Baylor he continued his researches but, desiring further training, he resigned his professorship to become a fellow of the National Research Council and spent a year working under Jules Bordet at the Pasteur Institute of the University of Brussels. Upon his return to this country he accepted an assistant professorship of bacteriology at the College of Physicians and Surgeons, Columbia University. The following year he was made an associate professor, which post he held for only one year, resigning to become affiliated with the Rockefeller Foundation. During the year 1927–28 he served as field director of the International Health Board at Manila in the Philippines, and was a member of the Advisory Committee to the Governor General for the Control of Leprosy. At the completion of this work he again became a member of the staff

of Columbia University, being appointed professor of bacteriology of the College of Physicians and Surgeons and director of the School of Tropical Medicine at the University of Puerto Rico. In 1931 he was invited to the deanship of the School of Medicine, The George Washington University, a post which he held at the time of the flight of the Clipper. He also held the post of professor of bacteriology and executive officer of the department of bacteriology, hygiene and preventive medicine.

Both the School of Tropical Medicine and The George Washington University profited by his vision and organizing ability. During his régime the School of Tropical Medicine prospered both materially and scientifically. What he accomplished at the School of Medicine of The George Washington University was truly amazing. He brought the school into national prominence. With his driving enthusiasm and love of research he inspired all those about him to greater accomplishments. Throughout his deanship of seven years, he held uncompromisingly to his high ideals of medicine. What he did for the school can be no better stated than by what Dr. H. H. Donnally, professor of pediatrics in the Medical School, wrote of him soon after his disappearance:

> His place can not be readily filled for a long time. The next few years will prove how much George Washington will miss the leaven of science worked up by Dr. McKinley. . . .
>
> He was an inspiring leader and did many things to advance the school, to enrich its student life and to stimulate accomplishment by men composing the faculty. He was enthusiastic and sympathetic for our scientific aspirations and ambitions.
>
> He lived the adventurous life, explicitly so, and lost his life a martyr to scientific endeavor.

Perhaps the most amazing aspect of the career of McKinley was the research he was able to accomplish under the exacting administrative load that he carried for the greater part of his professional life. Communications on a variety of subjects appeared throughout his fifteen years of scientific endeavor. Such subjects as bacteriophage, toxic and insulin-like substances in fruit, effect of fresh adrenal cortex on the white rat, toxicity of globulins, effect of ultra-violet light upon phage and viruses, microbial respiration, cerebral circulation, herpetic encephalitis, *Leptospira icterohaemorrhagiae* in wild rats of the Philippines, experimental measles in monkeys, salivary gland poison of *Aëdes aegypti*, acute filarial lymphangitis, cultivation of *Mycobacterium leprae*, epidemic encephalitis, effects of tropical climate under experimental conditions, etiology of leprosy, geography of disease and sulfanilamide in virus diseases, are some of the subjects which engaged his attention and attested to his wide interests and to his versatility. His strongest interests, however, fell definitely along certain lines. These are unquestionably the phage, encephalitis, leprosy and the geography of disease. These subjects attracted his greatest efforts, and in each of these fields he made noteworthy contributions. There is reason to believe that time and history may record some of his contributions as landmarks.

Of perhaps equal value to McKinley's actual experimental contributions were his contributions to the field through his efforts on the behalf of and in the organization of various societies and committees. He was a man who could accomplish things. His time and energy were repeatedly called upon. He gave unstintingly of these and devoted himself unselfishly to the furtherance of these organizations. Men learned to lean upon him.

The society to which he devoted perhaps the greatest amount of time was the American Association for the Advancement of Science. He was in full sympathy with the purposes of this society and what it was doing, and threw himself wholeheartedly into the solution of problems facing the association, as a member of the executive council. He devoted likewise much time and effort to the problems of the American Leprosy Foundation and was secretary and member of the Medical Advisory Board for a number of years.

At the time of his trip on the Clipper, McKinley was president of the American Association of Pathologists and Bacteriologists, and was on the Executive Committee, Division of Medical Sciences of the National Research Council. He served on the editorial boards of the Society of American Bacteriologists and of the American Association of Immunologists. He was also a member of numerous other medical and scientific societies here and abroad.

McKinley possessed a great capacity for friendship and created innumerable friends, not only in the national capital and through the nation, but also in many countries throughout the world. From the many letters written to his family following the disappearance of the Clipper it was evident how dearly he was held in the hearts of his friends, how deeply they appreciated his kindliness and generosity, how they had counted on his advice and counsel and how they treasured his friendship.

Lastly, a tribute should be accorded the loyal companion whom he had by his side throughout all his endeavors, for Mrs. McKinley has ever graciously and sympathetically assisted him. He also had the pleasure of having two charming and talented guests in his home for 17 years and 19 years, respectively, his son, Royce Baldwin, and his daughter, Elsbeth Janet, to whom he has left a fine heritage "to carry on."

Vincent du Vigneaud

Cornell University
Medical College

FREDERICK TILNEY

WITH the death of Dr. Frederick Tilney, on August 7, the American Museum lost a faithful friend and its staff an esteemed colleague. Dr. Tilney was appointed in 1932 to the honorary post of research associate in the department of comparative and human anatomy, but for several preceding years he had cooperated with the departments of vertebrate paleontology and comparative anatomy, making researches pertaining to the brains of fossil mammals and of prehistoric man. When the museum series of James Arthur annual lectures on the evolution of the human brain was inaugurated in 1932, he delivered the first lecture. During the past year he had planned a comprehensive research program, centering more of his endeavors than previously at the museum.

In the larger world of science and medicine, Dr. Tilney was among the few eminent neurologists. His more formal activities were those of practicing physician, consultant in neurology to several hospitals, professor of neurology and neuroanatomy at the College of Physicians and Surgeons of Columbia University, and medical director of the Neurological Institute of the New York Medical Center. A number of important research projects were actuated or directed by him. His enthusiasm for investigation led him to make significant and outstanding contributions, not only in the clinical and social aspects of neurology, but in studies of brain development, structure and function; sensory analysis; the evolution of the brain with relation to behavior and intelligence; and also to point out the philosophic implications of such studies. Besides numerous scientific papers published in journals and periodicals, he was the author of three important works on the brain. "The Form and Functions of the Central Nervous System" (in collaboration with Professor H. A. Riley), first published in 1920, serves as one of the more comprehensive text-books on the subject. "The Brain from Ape to Man," a monumental work in two volumes, published in 1928, is a comparative study of the brains of man and other primates, focused to illuminate the evolution and development of the human brain. "The Master of Destiny," published in 1930, is a popular presentation of the evolutionary history of the human brain—"a biography of the brain"—with some chapters of estimates, judgments and evaluations.

Aside from his scientific work, Dr. Tilney was a scholar in the liberal sense, with an eager interest in the arts and humanities. He was modest, simple, direct and sincere. Perhaps even more than for his work he was respected for unusual personal qualities. His colleagues, associates and acquaintances came to regard him with esteem and affection because of his inspiring courage, his wisdom and his gentleness. His superb life will endure in his achievements, but also in the hearts of his friends. His character seems peculiarly well portrayed by the following passage from Marcus Aurelius Antoninus, for whose observations he had remarked pleasure and respect:

> One man, when he has done a service to another, is ready to set it down to his account as a favor conferred. Another is not ready to do this, but still in his own mind he thinks of the man as his debtor, and he knows what he has done. A third in a manner does not even know what he has done, but he is like a vine which has produced grapes, and seeks for nothing more after it has once produced its proper fruit. As a horse when he has run, a dog when he has tracked the game, a bee when it has made the honey, so a man when he has done a good act, does not call out for others to come and see, but he goes on to another act, as a vine goes on to produce again the grapes in season. . . .

GEORGE PINKLEY
AMERICAN MUSEUM OF NATURAL HISTORY

RECENT DEATHS AND MEMORIALS

DR. THOMAS LYTTLETON LYON, professor emeritus of agronomy at Cornell University, died on October 7 at the age of sixty-nine years.

JOHN WILLIAMS DAVIS, of Petersburg, Va., consulting engineer with the Atmospheric Nitrogen Corporation and the Solvay Process Company, known for his work on the separation of helium from natural gas and on nitrogen fixation, died on October 4 at the age of fifty-one years.

THE Yale University School of Medicine has arranged an exhibition in recognition of the two hundredth anniversary of the death of Herman Boerhaave, who occupied the chairs of clinical medicine, botany and chemistry at the University of Leyden during some twenty years of his life. The books written by Boerhaave which are on exhibition come from the library of Dr. John F. Fulton, Sterling professor of physiology. The exhibition will be left in place until October 15 in the foyer of Sterling Hall of Medicine. There is exhibited the first edition of Boerhaave's "Institutiones Medicae," published in 1708, which for the first time established physiology as an academic discipline in the medical curriculum. "Institutiones Medicae" was written by Boerhaave to give his students a background of knowledge of normal function; in the work he introduces the term "physiology" in its modern connotation.

SCIENTIFIC EVENTS

WORK OF THE BRITISH HYDROGRAPHIC DEPARTMENT

The annual report of the Hydrographer of the Navy, Rear-Admiral J. A. Edgell, for 1937, summarized in the London *Times*, shows that the Service surveyed during the year a total length of 667 miles of coastline and sounded an area of 6,599 square miles. Seven ships were employed, three in home waters and four in foreign stations. In addition a surveying unit was employed on the West Coast of Scotland on a survey from Loch Killisport to Loch Crinan, and also surveyed Lake Windermere. The South Coast of England survey continued its work at Portsmouth, the Solent and Plymouth.

Provision has been made in the 1938 estimates for a new 53-foot surveying launch, equipped with echo sounding gear, for use by the latter survey. The tidal stream survey of the waters surrounding the British Isles, begun in 1933, was continued, observations being made by surveying vessels at 26 stations, at one station by the Southampton Harbor Board, and at 15 stations by the French Hydrographic Society.

Work on four new ships for service in home waters and two for service on foreign stations was continued, in addition to the Royal research ship *Research*. The keel of the latter was laid on September 9, 1937, and satisfactory progress has been made since that date.

A statistical summary shows that 63 new charts (compared with 29 in 1936) were published for general use, and 49 new editions of charts (compared with 45 in 1936). The number of corrections to charts inserted by hand was 259,888. The department issued 2,472 Admiralty notices to mariners during the year. The net receipts from the sale of charts amounted to £67,727, compared with £51,351 in 1936.

There was again an increase in the number of rocks and dangers to navigation discovered by surveying ships, the total being 135, against 112 in 1936, and 53 in 1935. In addition, 21 were reported by other British warships and 302 by various British and foreign governments and authorities, making a total of 458, against 435 in 1936 and 358 in 1935.

The number of broadcast wireless navigational warnings issued was 541, being larger than ever before and 49 more than in 1936. These reports are telegraphed from the Admiralty to various wireless stations in the British Isles, and are broadcast from these stations according to the area affected by the warning.

THE CHILDREN'S HOSPITAL RESEARCH FOUNDATION

Announcement is made by Dr. A. Graeme Mitchell, director of the Children's Hospital Research Foundation, Cincinnati, and Dr. Glenn E. Cullen, director of laboratories, that upon authorization of the board of trustees a Scientific Advisory Council has been appointed. This consists of:

Dr. O. T. Avery, member of the Hospital of the Rockefeller Institute for Medical Research.

Dr. Ernest Goodpasture, professor of pathology, Vanderbilt University School of Medicine.

Dr. A. Baird Hastings, professor of biological chemistry, Harvard University Medical School.

Dr. A. N. Richards, professor of pharmacology, University of Pennsylvania School of Medicine.

The second meeting of this council was held in Cincinnati on September 28 and 29.

The Children's Hospital Research Foundation was established in 1929 through the generosity of William Cooper Procter. Its facilities include its own laboratory building and affiliations with the Children's Hospital of Cincinnati, the Pediatric Department and the Contagious Disease Pavilions of the Cincinnati General Hospital, the Children's Convalescent Home, the Babies' Milk Fund Association and the Ohio Soldiers' and Sailors' Orphans' Home at Xenia, Ohio. The Children's Hospital and its Research Foundation are affiliated by agreement with the University of Cincinnati, the professor of pediatrics in the University of Cincinnati being the director of the medical service and the director of the foundation. Approximately one hundred and fifty publications have appeared from the research foundation. Present plans contemplate additions to the staff and certain new lines of investigation.

REORGANIZATION OF THE U. S. DEPARTMENT OF AGRICULTURE

Secretary Henry A. Wallace has announced important changes in the structure of the U. S. Department of Agriculture. These are designed to expedite the services of the department to the public. The new organization unifies four lines of work which have assumed importance in recent years as new responsibilities have been laid on the department.

(1) The forming of programs and plans to guide the entire group of agricultural adjustment, conservation and marketing services to farmers and the general public is assigned to the Bureau of Agricultural Economics, which will be charged with department-wide responsibility.

(2) The execution of marketing work is lodged in four units responsible to the secretary through a director of marketing and regulatory work.

(3) The execution of all physical land-use programs which involve operations by the Government on farm lands is consolidated in the Soil Conservation Service.

(4) Research work in the field of agricultural and in-

dustrial technology is placed under unified direction.

To direct the planning work Dr. H. R. Tolley, administrator of the Agricultural Adjustment Administration, formerly director of the Giannini Foundation of the University of California, has become chief of the reconstituted Bureau of Agricultural Economics.

Secretary Wallace, according to the official announcement, said:

It is imperative that we establish over-all planning work for the whole department in order to provide for proper functioning of the many new activities authorized in recent years by the Congress. It has become all the more necessary since the department last July entered into a significant and far-reaching agreement with the Land Grant College Association. Under the agreement the colleges and the department are establishing democratic procedure that will give farm people an effective voice in forming, correlating and localizing public agricultural programs. Farm people and official agencies in the states are now forming community, county and state groups to carry on land-use planning and program building. In the expanded Bureau of Agricultural Economics, the department is now establishing its part of the machinery needed to integrate state and local planning with general planning and program-forming activities within the department.

To consolidate the marketing work, A. G. Black leaves the post of chief of the Bureau of Agricultural Economics and becomes director of the Bureau of Marketing and Regulatory Work. His associates, the chiefs of the four agencies combining all marketing and regulatory activities, will be: Jesse W. Tapp (formerly assistant administrator of the AAA), surplus commodity diversion and marketing agreements programs; C. W. Kitchen (formerly assistant chief of the Bureau of Agricultural Economics), marketing research, service and regulatory work; J. W. T. Duvel, continuing as chief, Commodity Exchange Administration; and Joshua Bernhardt, continuing in charge of activities under the Sugar Act of 1937. R. M. Evans leaves the post of assistant to the secretary and becomes administrator of the Agricultural Adjustment Administration.

The consolidation of physical operations in land-use programs for farm land brings them all under H. H. Bennett, chief of the Soil Conservation Service. Widening the uses of farm products is the purpose of merging technological research work, including that in the Bureau of Chemistry and Soils and that in the Bureau of Agricultural Engineering, under the direction of the chief of chemistry and soils, H. G. Knight.

THE DEDICATION OF THE ABBOTT LABORATORIES

THE fiftieth anniversary of the founding of the Abbott Laboratories, pharmaceutical manufacturers, in North Chicago, was celebrated on October 7 with the dedication of a new laboratory building.

There was a special program in the afternoon, following an inspection tour in the morning. The speakers and their subjects were: Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, "The University and the Public Welfare"; Dr. Herbert M. Evans, Morris Hertzstein professor of biology at the University of California, "The Task and Spirit of Research," and Dr. Thomas Parran, surgeon general, U. S. Public Health Service, Washington, D. C., "Research and Public Health." In the evening a program was presented at the Palmer House with the following speakers: Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* "The Contributions of Organized Chemistry"; Dr. George D. Beal, assistant director of the Mellon Institute, Pittsburgh, "The Scientific Development of Drug Standards"; Dr. Morris Fishbein, Chicago, editor of the *Journal* of the American Medical Association, "The Contributions of Medicine to the Public Welfare."

The new building is three stories high with an attic and basement, providing facilities for the chemical, bacteriologic, botanic, medical and pharmaceutic research activities of the firm. In addition to laboratories it contains a micro-analytic laboratory, a library with accommodation for 20,000 volumes, hot and cold rooms for stability studies, dark rooms on each floor for the use of optical instruments, one dark room for use as a laboratory for light-sensitive reactions and an air-conditioned auditorium seating 800 persons.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT its annual meeting each year the council of the association votes a number of grants in aid of research. In order that applications for such grants may be examined and passed on by the committee on grants in time for the annual meeting, they must be filed in the office of the permanent secretary before November 1 on forms that will be supplied upon request. These forms contain full instructions respecting the information that must support the applications.

The funds from which the grants are made are derived from the income of endowments of the association by various gifts, from investments of reserve funds and from the income from the life membership fees of deceased life members. Although the income available for the support of research is as yet very limited, it fortunately has been increased in recent years by gifts from a friend of the association.

As a rule grants are not made to pay salaries of investigators or traveling expenses or for printing reports of the results of investigation. They are gen-

erally made for assistance in completing research projects that are well under way and for which valuable conclusions within limited periods may reasonably be expected. Often they complete the requirements for funds which have been partly met by the institutions with which the applicants are associated or from other sources.

Section I (Psychology) of the association will meet in Richmond, Va., from Tuesday, December 27, to Thursday, December 29. In addition to the usual program of contributed papers, there will be, on Wednesday, December 28, a symposium on "Recent Advances in the Psychology and Physiology of Audition" under the chairmanship of Dr. Elmer A. Culler, University of Rochester.

Since the change of the date of the meetings of the American Psychological Association from Christmas to September, attendance at the meetings of Section I has steadily increased. It is hoped that a large number of psychologists will attend and participate in the Richmond meetings. The character of the general program must depend on the submitted papers, and members of Section I are urged to send in abstracts. Both theoretical and experimental papers are acceptable.

All fellows and members of the section who wish to read papers should submit abstracts in duplicate (not more than 300 words in length) of the papers which they wish to present. Please note on the abstracts the time required for presentation up to a limit of 15 minutes. Abstracts should reach the section secretary, Leonard Carmichael, Tufts College, Medford, Massachusetts, not later than November 11.

F. R. Moulton,
Permanent Secretary

SCIENTIFIC NOTES AND NEWS

The Perkin Medal of the Society of Chemical Industry for achievement in industrial chemistry has been awarded to Dr. Walter S. Landis, vice-president of the American Cyanamid Company.

Dr. Nevin M. Fenneman, professor of geology and geography at the University of Cincinnati, will be presented with the gold medal award of the Geographic Society of Chicago on October 22 at the annual post-vacation luncheon of the society.

At the opening exercises of the Medical School of the University of Michigan on October 1, the degree of doctor of science was conferred upon Dr. Peyton Rous, member of the Rockefeller Institute for Medical Research, New York, who delivered the convocation address.

The Harvard Alumni Bulletin reports that in honor of Dr. Walter B. Cannon, George Higginson professor of physiology at the Harvard Medical School and national chairman of the Medical Bureau to Aid Spanish Democracy, a fund is being raised by his friends for relief work in Spain. The money will be sent this month, together with a portrait of Dr. Cannon, to Dr. Juan Negrin, premier of Spain, professor of human physiology at the University of Madrid and director of the physiological laboratory of the Ramón y Cajal Institute, a friend of Dr. Cannon.

Dr. Albrecht Penck celebrated his eightieth birthday on September 25. Professor Penck held for twenty years the chair of geography at the University of Vienna, when in 1906 he was appointed to take charge of the Museum of Marine Studies in the University of Berlin. In 1922 he was made director of the Institute of Geography of the university, becoming emeritus in 1927.

It is reported in *Nature* that Professor Alfred Kühn, director of the Kaiser-Wilhelm Institute of Biology, Berlin; Dr. Hugo Hassingen, professor of geography at the University of Vienna, and Dr. Hans Ahlmann, professor of geography at Stockholm, have been elected members of the Prussian Academy of Sciences in the physico-mathematical class.

Dr. Harold C. Urey, professor of chemistry at Columbia University, will give the George F. Baker lectures in chemistry at Cornell University for the academic year 1938–39 in November and December. Dr. G. B. Kistiakowsky, of the department of chemistry at Harvard University, will be Baker lecturer in February and March, and Dr. P. W. Bridgman, professor of physics at Harvard University, will lecture in April and May.

Dr. Thomas Francis, Jr., member of the staff of the International Health Division of the Rockefeller Foundation, in charge of research on influenza, has been appointed professor of bacteriology in the New York University College of Medicine. The chair in bacteriology became vacant recently when Dr. William S. Tillett was assigned to the professorship of medicine formerly occupied by the late Dr. John Wyckoff.

Dr. Hiram Bentley Glass, of Stephens College, Columbia, Mo., has been appointed assistant professor of biology at Goucher College, Baltimore.

Dr. S. C. Werch, demonstrator in physiology at the School of Physic, Trinity College, Dublin, has been appointed instructor in the department of pharmacology in the Medical College of the State of South Carolina.

Dr. W. G. Clark, of the Scripps Metabolic Clinic, La Jolla, Calif., has been appointed instructor in the department of zoology at the University of Minnesota.

DR. I. M. KOLTHOFF was referred to in a recent issue of SCIENCE as head of the department of chemistry at the University of Minnesota. His correct title is chief of the division of analytical chemistry.

R. W. TRULLINGER, principal experiment station administrator and agricultural engineer, who has been associated with the Office of Experiment Stations of the U. S. Department of Agriculture since 1912, has been appointed to the newly established position of assistant chief. His work will be, in association with the chief, to "direct and supervise the administration of the Federal Acts granting funds to the states for research with all correlated responsibilities and to assume leadership in the maintenance of desirable research relationships between states and between state and Federal agencies with respect to these Federal-grant Acts."

H. C. SAMPSON retired from the post of economic botanist at the Royal Botanic Gardens, Kew, on September 30. He is succeeded by Sir Geoffrey Evans, who is retiring from the post of principal of the Imperial College of Tropical Agriculture, Trinidad. He has in turn been succeeded in the principalship by O. T. Faulkner, director of agriculture in Nigeria.

DR. M. S. KRISHNAN has been appointed assistant director of the Geological Survey of India. He is the first Indian to be appointed to this post.

THE following fellows in the medical sciences, appointed by the Medical Fellowship Board of the National Research Council during the year 1938–39, have commenced their fellowship appointments: Louis K. Alpert, at the Rockefeller Institute for Medical Research; Philip P. Cohen, at the University of Sheffield (England); Thomas H. Davies, at California Institute of Technology; Carl L. Larson, at the University of Rochester; Arthur P. Richardson, at the Johns Hopkins University; Jane A. Russell, at Yale University; Wilfred W. Westerfeld, at the University of Oxford.

DR. W. F. PROUTY, head of the department of geology of the University of North Carolina, has been made a member of the Board of Consultants of the Tennessee Valley Authority in place of Professor W. J. Mead, of the Massachusetts Institute of Technology, who recently resigned.

DR. PAUL R. CANNON, professor of pathology of the University of Chicago, has been appointed a member of the Medical Fellowship Board of the National Research Council for the period ending June 30, 1941, to complete the unexpired term of Dr. Eugene L. Opie, who has resigned.

ELMER H. JOHNSON, industrial geographer in the Bureau of Business Research of the University of Texas, has been given leave of absence to make a study of regional industrial development in a group of southeastern states.

DR. FOREST RAY MOULTON, permanent secretary of the American Association for the Advancement of Science, will open the annual lecture series of the Louisiana State University chapter of Phi Kappa Phi on October 27.

AT the inauguration of the one hundred and fourteenth annual session of the Jefferson Medical College, Philadelphia, the introductory lecture was delivered by Dr. Charles M. Gruber, professor of pharmacology, on "Research, the Key to Progress."

SIR EDWARD MELLANBY will deliver the Harveian Oration to the Royal College of Physicians of London on October 18.

THE two hundred and twenty-third regular meeting of the American Physical Society will be held at the University of Chicago on Friday and Saturday, November 25 and 26. The headquarters hotel will be the Hotel Windermere.

THE annual meeting of the Air Hygiene Foundation will be held on November 17 at the Mellon Institute, Pittsburgh. The program includes progress reports on the research for preventing industrial disease and improving the health of employees. Other reports, for industrial management, will cover legal, economic and social phases of industrial health.

THE fifth annual meeting of the New York State Geographical Association will be held at the State Teachers College at Buffalo on November 5. In the morning session, papers on the geography of New York State will be presented. A field trip is planned for the afternoon, with a banquet and an invited speaker for the evening.

BRADFORD WILLARD, press secretary of the Pennsylvania Academy of Science, reports that the regular summer meeting of the academy was held on August 12 and 13 in Chester County. Seventy-five members and guests attended. The academy assembled at Coatesville on the twelfth in the afternoon and proceeded on a field trip. Two hours were spent in the du Pont Longwood Gardens, where items of unusual botanical interest were observed. From the gardens, the trip continued through the region of ancient, crystalline rocks where both geology and botany proved interesting. Particularly striking was the difference between the vegetation of the serpentine barrens and intermingled areas of pegmatite. A business meeting and reception occupied the evening. The last day was devoted to further field studies. The first stop was the arboretum of the Westtown School. Following that parties visited the serpentine barrens, Woods Chrome Mine and other points, chiefly of in-

interest to the mineralogist and botanist. The Chester County Natural Historical Society, Dr. E. T. Wherry, of the University of Pennsylvania, and Dr. E. M. Gress, state botanist of Pennsylvania, were largely responsible for the successful planning and conducting of the meeting and field trips.

The fourth annual fall Field Camp of the department of geology and geography of Syracuse University was held in the vicinity of Catskill, New York, from September 12 to 17, under the direction of Dr. George B. Cressey, chairman of the department. Headquarters were at the Kiskatom, a country hotel near Palenville.

The first meeting of the London Scientific Film Society was held on September 20. The society plans to give a series of shows of scientific films to its members and their guests during the coming season. Professor Sir Frederick Gowland Hopkins, Sir William Bragg, Professor L. Hogben and Professor Julian Huxley are patrons of the society, which has about a hundred and fifty members.

George A. Hormel and Company, of Austin, Minn., has made an annual grant of $25,000 to the University of Minnesota to establish the Hormel Research Foundation for the promotion of researches in the field of food technology. Most of the research will be devoted to problems of importance to the packing industry. The work will be conducted by a committee consisting of Professors George O. Burr, R. A. Gortner, H. O. Halvorson, Walter M. Lauer and Samuel C. Lind, chairman. The post-doctor of philosophy fellows who will take part in the research in 1938–39 are: Claude H. Hills (biochemistry); J. P. Kass (biochemistry); Lewis S. Keyser (organic chemistry) and Floyd C. Olson (industrial bacteriology).

Under the terms of the will of the late Miss Grace M. Edwards, of Boston, the president and fellows of Harvard College will receive $25,000 for the benefit of the Arnold Arboretum.

Free illustrated lectures at the New York Botanical Garden have been announced for three o'clock on Saturday afternoons as follows: October 1, Rock Garden Construction, A. C. Pfander, assistant superintendent; October 8, Humoring the Garden Soil, T. H. Everett, horticulturist; October 15, Botanists and Human Progress, J. H. Barnhart, bibliographer; October 22, Winter in Oaxaca, W. H. Camp, assistant curator; October 29, Garden Work with Shrubs, P. M. Koster, nurseryman; November 5, Some Important Drug Plants, Professor Wm. J. Bonisteel, Fordham University; November 12, Alpine Flowers of Central Greece, Professor Clarence H. Young, Columbia University, and Mrs. Young; November 19, Origin and Improvement of Plants, A. B. Stout, curator of education and laboratories; November 26, The Romance of Plant Names, H. A. Gleason, head curator and assistant director.

An Associated Press dispatch dated from Berlin on October 4 reads: "German medical journals no longer may accept articles by Jewish doctors, the Nazi Commissioner for Medical Journalism ordered. The order added that 'our German doctors will subscribe to foreign journals only if they are published by Aryan publishers and edited by Aryan doctors.'"

DISCUSSION

AN INSTANCE OF PROGRESSIVE INDIVIDUATION IN VISUAL FUNCTIONS

This is simply an anecdote. It is utterly lacking in scientific control, but, like all such incidents, it had to be "caught on the fly" and taken for what it is worth. At least it serves to illustrate what I mean by individuation in the sensory field.

The incident which I am about to relate concerns my dog, Ponto. In breeding he is three fourths German police and one fourth Scotch collie. I procured him when he was ten weeks old, and till this incident kept him tied most of the time. Occasionally when I was going about the premises I turned him loose, and particularly I did so each morning when I went for my mail at the rural delivery box. This is south of the main entrance to my laboratory. These daily trips were occasions of great joy to Ponto, as he showed by leaping upon me, and especially by taking the lower end of my cane in his mouth and playing with it, then dropping it only to catch it up again. He obviously regarded my cane and myself as friendly creatures.

This went on for about four weeks, when Ponto had a new and strange experience with me and my cane. Instead of going out of the south door of my laboratory I went out of the west door. Ponto, being free, met me instantly and took the tip of my cane in his mouth as usual. He played about my feet as I walked along till we passed the servants' quarters to the northwest and entered the poultry yard beyond, the poultry yard being so situated as not to be visible from the west door of my laboratory on account of the servants' quarters. When we entered the poultry yard Ponto set upon the hens and gave them a merry chase. To chastise him I reprimanded him loudly and threw my cane at him. He fled precipitately and ran out of danger back to the laboratory.

The next morning Ponto met me as usual at the

front door for the excursion to the mail box. He made the customary salutation and played with my cane as I walked along. There was nothing in his behavior to indicate that he remembered the incident of the day before in the poultry yard or regarded either myself or my cane as a menace. But later the same day I went out of the west door of my laboratory again on my way to the poultry yard. Ponto met me at the door and, taking the tip of my cane in his mouth, played along happily till we passed the servants' quarters and came in view of the poultry yard. At that moment he stopped and seemed to survey the situation. His ears and tail drooped disconsolately, and, turning about, he went sorrowfully back to the laboratory. These reactions were repeated for several days following.

Now, the poultry yard had done nothing to chastise Ponto. It was myself and my cane that had functioned in that capacity. According to the theory of association the dog would be expected to associate (synthesize) the chastisement with me and my cane, the moving objects which overtly effected the reprimand. But, obviously, my cane and I held no menace for him so long as we were alone in his field of vision. As soon, however, as we made a common visual pattern with the poultry yard he recognized a menacing situation. It was the total pattern that acted as the stimulus. And this did not require an act of synthesis by Ponto. The totality (oneness) was primary, and in the primary total visual pattern none of the elements had acquired a sufficient degree of individuality of their own for the dog to recognize them as such in the composition of the field and to attach to them their true significance. In other words, Ponto could not individuate my cane, myself and the poultry yard.

But Ponto's behavior when he was six months old suggested that he had made progress in powers of visual individuation. He would then seat himself before me while I stood quietly, and would gaze into my eyes intently and inquiringly as if he expected something to come out of them. He had obviously noticed that my eyes were a part of me, and a very special part, for after we had looked each other straight in the eyes for a while, and without either of us making any other movement, he would playfully leap at my face. This leap was so sudden and close that I had to dodge to escape it.

Possibly I owe psychologists an apology for this trespass upon their field, particularly those who give little consideration to neurology or have no sympathy for Gestalt psychology. Kuo,[1] for instance, has criticized my "uncritical acceptance of the 'gestalttheorie.'" This does not seem to me quite justified, for I had not thought of accepting any theory of psychology. In fact I have not studied the theory of Gestalt in its broader implications. But I am in agreement with the theory in the interpretation of the relation of the part to the whole in organismic behavior. And in so far as I have advocated the theory I have been impelled by facts of structural and functional growth of the nervous system and the organism. In both structural and functional development I see the antagonistic processes of integration and individuation; the one tending to maintain the integrity of the organism, the other tending to dismember it. Normal development requires the whole to dominate the parts. If this is in accord with the *"gestalttheorie,"* as I think it is, all well and good, but beyond this I have no personal interest in the theory.

Within normal limits individuation makes for greater efficiency of living, both motor and sensory. In the visual functions I consider it as the biological process which makes possible a figure on a ground. Genetically, we see, first, totalities (wholes); later we "regard" parts of the totalities. It is possible that Ponto in his younger days saw my cane as a part of myself, for he was constantly trying to lick my hands, though I avoided this caress as much as possible and reproved him for it. Taking the tip of my cane in his mouth may have given him a similar satisfaction and he could do this with impunity. Only later, I think, was he able to "regard" my cane as such; for this would be possible only through the process of individuation. In former writings I have spoken of this process as "reduction" of the field of stimulation,[2] or "progressive restriction of the stimulogenous zone,"[3] or "progressive reduction in the extent of the reflexogenous zone or range of the impinging stimuli."[4]

In this as in all my communications I take pleasure in acknowledging a grant by the Josiah Macy, Jr. Foundation to support my work.

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STROBOSCOPIC ILLUSIONS CAUSED BY LIGHTNING

ON June 10, 1938, a thunder-storm lasting from 5:30 to 7:30 P.M., accompanied by brilliant lightning, occurred at Iowa City, Iowa. The sky, piled high with white cloud masses, was brightly illuminated at frequent intervals during this storm. An 8-inch electric fan running on a window sill facing the storm was sharply silhouetted against this light background throughout each flash. Lasting through many flashes

[1] Zing Yang Kuo, *Psychological Review*, 39: 499–515, 1932.

[2] G. E. Coghill, *Proc. Nat. Acad. Sciences*, 16: 637–64[illegible], 1930.

[3] *Ibid., Archives of Neurology and Psychiatry*, 21: 9[illegible]–1001, 1929.

[4] *Ibid., Jour. Gen. Psychol.*, 3: 431–435, 1930.

brief stroboscopic illusion was noted on the revolving n blades. This was more clearly seen with the room ghts turned off. Every stroke did not produce exactly e same illusion on the fan blades. A number of ashes caused the revolving blades to appear practi-lly motionless; with others they seemed to revolve owly in the direction of their original rotation. Some ashes produced no effects. During the present obser-tions it was estimated that at least 80 per cent. of the ashes created a stroboscopic illusion upon the whirl-g fan blades. Noticeable flickering of the flash fre-ently characterized those strokes creating this illu-on. No flashes were observed that caused the fan ades to appear to revolve backwards.

Recent researches upon lightning by McEachron and cMorris[1] have demonstrated that what appears to be single stroke is often a series of flashes, spaced a action of a second apart. Such multiple strokes ay consist of as many as 40 separate discharges, the terval between them varying from 0.0006 to 0.53 cond. Their observations have indicated that about) per cent. of the strokes in some storms were mul-ple. This paper should be consulted for details possible to cite in a short note.

These researches have clearly indicated that certain lts of lightning are made up of a rapidly occurring ries of separate flashes. A multiple stroke of light-ng may, therefore, create the same type of illusion on the revolving blades of an electric fan as do the termittent light flashes produced by a stroboscope.

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ADVANTAGES OF $F_g = kma$

The much-debated and troublesome gravitational easure of force can be handled in only two essentially fferent ways. These are $F_g = kma$ and $F_g = \frac{wa}{g}$. Each s its advantages and each has its ardent advocates, so at further discussion may be a waste of time. How-er, I should like to point out one or two possibly w reasons which seem to me to give the weight of gument in favor of *kma*.

In this method k is a numerical constant which, in the metric system, converts dynes to grams of force (F_g). In the form $F_g = kma$, it equals approximately 1/980 and is exactly analogous to the number 12, which converts a length measured in feet to the same length measured in inches. Such a number has no dimension as the word is usually understood. It is simply the quotient of one foot divided by one inch. The result is twelve, not 12 *in/ft*. If you ask how many quarters make a dollar, the answer is four, not 4 quarters/dollar. The latter would amount to saying: "four quarters per dollar quarters make a dollar"; which is certainly redundant. Thus we may write $L_{in} = 12L_{ft}$, or $F = 980\ F_g$, where 12 and 980 are numerical ratios of the same physical quantity, and are therefore numbers having no dimensions.

The other method is based on a force-length-time system of units instead of a mass-length-time system. The force (weight) w is converted to a mass by dividing by g, and this new mass, measured in units of 980 grams, gives force in grams when multiplied by the acceleration measured as usual. The numerical labor involved is identical in both methods, so the only question is as to which makes for the least confusion. It seems to me that *kma* is the least confusing, since it does not depart from the c.g.s. system in calculating the non-c.g.s. quantity, force measured in grams. The trouble with $F_g = \frac{wa}{g}$ is that it introduces practically two non-c.g.s. quantities, namely the weight w, and the mass w/g measured in 980-gm units. Possibly this system would be preferable if we always used gravitational units and nothing else. That is why it appeals to the engineer, who clings to the good old pound weight and ignores the possibility of a pound mass. But the use of the metric system either with c.g.s. or m.k.s. units is certainly increasing. So it seems to me that since we can not yet ignore force pounds and force grams, we should use that method of dealing with them which is the least confusing and which deviates as little as possible from the concept of force expressed by $F = ma$.

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QUOTATIONS

THE PHYSIOLOGICAL CONGRESS AT ZURICH

Amid auspicious surroundings the International ysiological Congress had its sixteenth, or jubilee, eeting at Zurich from August 14th to 19th. The esident, Professor W. R. Hess, in a happy address of welcome, pointed out that the congress had been conceived in England in 1888, but was born at Basel in September of 1889 when a group of 129 physiologists met to hold their first congress. It was highly fitting, therefore, that the congress should return to Switzerland to celebrate its fiftieth anniversary; this time with a registration of more than 1,600 members.

[1] K. B. McEachron and W. A. McMorris, *General Elec-c Review*, 39: 487–496, 1938.

In recognition of the occasion the Physiological Society had appointed Dr. K. J. Franklin to write "A Short History of the International Congresses of Physiologists." This excellent record appeared in the *Annals of Science* for July 15th and in reprint form was presented by the society to all members of the congress. The "History" is appropriately dedicated to "Charles Scott Sherrington, one of the general secretaries of the congresses from 1892 to 1907, who by his experimental demonstrations at successive meetings and by his personal encouragement of younger physiologists has for half a century put into practice the principles laid down by the founders of the congresses."

The Zurich congress was notable for its observance of the principles of simplicity which Michael Foster and others insisted upon at the early congresses: a minimum of pomp and ceremony, no official delegates, quiet entertainment, often *en famille,* and a sympathetic and well-mannered press. The scientific proceedings were marvellously organized in five simultaneous programs beginning on Monday afternoon, August 15th, and continuing twice daily (save for the excursion on Wednesday afternoon) until Friday afternoon. A new and highly successful feature of the congress were the fifteen symposia embracing set topics of current interest such as the kidney, acetylcholine, fœtal respiration, adrenal cortex and vitamin B_2, at which the major contributions and principal discussions were by invitation. There were also many demonstrations, conspicuous among which was evidence of the growing popularity of cinematographic demonstration.

Scientifically speaking, it was generally felt that the Zurich congress was the most successful of any held in recent years, and it set a standard which English members will find it difficult to equal in 1941 when the seventeenth congress is to meet in Britain. From the international standpoint there were several features worthy of note. It was a source of profound regret, after the brilliant congress at Leningrad and Moscow in 1935, that not one Russian physiologist could be present in Zurich. Professor Orbeli, however, was elected to succeed Pavlov on the international committee, and it is earnestly hoped that we shall be able to welcome him and his colleagues in England in 1941. A source of gratification to the entire congress was the large delegation of physiologists from Spain, led by Professor Negrin himself and including Professor August Pi Sunyer of Barcelona and Professor Jaime Pi Sunyer of Santiago de Galicia. The German delegation was unexpectedly large, consisting of 130 members, though many eminent physiologists of Germany (including Bethe, Warburg, von Brücke and Otto Loewi) were conspicuous by their absence. Drs. Oskar and Cecile Vogt happily were present in Zurich. Apart from several junior students from European laboratories, only one physiologist came from the Far East (Professor Yas Kuno).

For its skill in handling the problems of diplomacy with which the congress was faced the Swiss committee deserves the admiration and gratitude of all those interested in the welfare of physiology; and in this connection the names of Professor Hess and of Professor Ernst Rothlin, the general secretary, come most prominently to mind, together with that of their able assistant, Dr. Oskar Wyss. After unanimously voting to accept the invitation to meet in England in 1941, the congress responded enthusiastically to Professor Houssay's invitation to meet in Buenos Aires in 1944; the South American invitation, however, will not be voted upon until 1941.—*Correspondent of The Lancet.*

SCIENTIFIC BOOKS

PHYSICS TEACHING AND THE TEXT-BOOKS

Usually at the beginning of the academic year a great variety of new texts, or new editions of surviving old-established text-books, arrive in astonishingly large numbers. The diversity of objectives and expectations of a physics course is probably the main reason for this flood of texts which attempt to satisfy the great differences of conditions to be met in this country. Physics is taught as a foundation for engineering and applied sciences, as a basis for natural philosophy, and finally as a part of the general survey course on the natural sciences which is becoming increasingly popular in secondary schools and colleges.

Depending on the purposes of the course as set by the instructor, the outlook on the subject is bound to vary. But the reason for the appearance of so many different texts is due not only to the different fundamental concepts or minimum requirements of a general physics course, but also to the variety of entrance requirements into colleges which exist in different parts of the country and in different schools. From those students who have had no high-school physics at all and hear about physics for the first time in the sophomore year, to those students who have had one year or more of college work and are required to take two years of physics, all intermediate stages are encountered. It is, therefore, to be understood that no two texts are alike and that in most cases each book will appeal to some special group only. Some of the texts submitted in Table 1 are written by authors long versed in undergraduate teaching in this country, while others are of English origin. The main difference between

TABLE 1

Author	Title	Year	Publisher	Price
Bidwell and Bayley	Physics	1936	Macmillan	$3.50
Bowden, A. T.	Man's Physical Universe	1937	Macmillan	
Champion and Davy	Properties of Matter	1937	Prentice-Hall	4.50
Culver, C. A.	A Textbook of Physics	1936	Macmillan	4.00
Edser, E.	Heat for Advanced Students	1936	Macmillan	1.75
Eldridge, J. A.	College Physics	1937	Wiley and Son	3.75
Erickson, H. A.	Elements of Mechanics—3rd Ed.	1936	McGraw Hill	2.25
Fermi, E.	Thermodynamics	1937	Prentice-Hall	3.00
Filon, L. N. G.	A Manual of Photoelasticity for Engineers	1936	Cambridge Univ. Press	1.50
Fletcher-Mosbacher-Lehman	Unified Physics	1936	McGraw Hill	1.80
Hadley, H. E.	A Class Book of Magnetism and Electricity	1936	Macmillan: London	2.50
Hirst, A. W.	Electricity and Magnetism	1937	Prentice-Hall	4.50
Hobbie, J .R.	Introduction to College Physics	1936	Farrar and Rinehart	3.50
Jones, A. T.	Sound	1937	D. van Nostrand	3.75
Kimball, A. L.	College Physics—5th Ed.	1937	Henry Holt and Co.	3.75
McLachlan	Acoustics	1936	Oxford Univ. Press	2.75
Millikan, R. A., Roller, D.	Mechanics, Molecular Physics	1937	Ginn and Co.	4.00
Osgood, W. F.	Mechanics	1937	Macmillan: New York	5.00
Page, N. C.	Lessons and Problems in Electricity	1936	Macmillan	2.75
Ramsey, A. S.	Electricity and Magnetism	1937	Cambridge Univ. Press	3.25
Ramsey, A. S.	Hydrostatics	1936	Cambridge Univ. Press	2.35
Schrader, J. E.	Physics for Students of Applied Science	1937	McGraw Hill	4.00
Spinney, L. B.	A Textbook of Physics	1937	Macmillan	3.75
Timoshenko and Young	Engineering Mechanics—Statics	1937	McGraw Hill	2.75
Timoshenko and Young	Engineering Mechanics—Dynamics	1937	McGraw Hill	2.75
Vigoureux and Webb	Principles of Electric and Magnetic Measurements	1936	Prentice-Hall	5.00
Williams, S. R.	Foundations of College Physics	1937	Ginn and Co.	4.00

American and English texts lies in the different emphasis on modern developments. All American authors attempt to make the subject more interesting by stressing modern developments and emphasizing the importance of modern physics in its applications to other sciences and industry. This tendency, which we believe is sound and worth-while, is noticeably lacking in the English texts. It seems that our English colleagues stress mainly the fundamental concepts of physics as given by the framework of classical physics and leave modern developments almost entirely to graduate study.

The new tendency to offer physics as a part of a survey course in the general sciences is particularly striking in the new book by Bowden. This book, written in an interesting and easily readable style, should be excellent in the hands of an experienced teacher or, better still, of a group of teachers administering the course. For where can a teacher be found nowadays who has the self-confidence and training to teach all the subjects of geology, astronomy, physiology, chemistry and physics? Moreover, the book can hardly be recommended as a book which the student could use without the help of an instructor, since most of the developments are sketched so briefly that they require amplification in the lecture or recitation, and since many statements need clarification and correction.

Of the great number of general physics texts, many, like Spinney, Kimball, Hobbie and Culver, appear in new editions brought up to date and somewhat enlarged. Of the new texts the book of Eldridge is remarkable for its enthusiastic approach. Problems are well chosen, and everywhere the author has tried to emphasize the clarity of concepts and their mathematical developments. It is unfortunate, however, that in an attempt to avoid the introduction of "abstract" mechanics the author starts with elasticity and liquids, which can scarcely be properly understood without the knowledge of elementary mechanics. The general feeling seems to be that no student can be interested enough in the development of mechanics, and so consequently many text-books make the introductory chapter more "interesting" by dealing with material which logically could only be treated after the concepts of mechanics are fully understood. In this respect the book of Williams is a notable exception. Carefully arranged in logical order—see, for instance, the introduction of magnetism!—this author has given a clear outline of the principles of classical physics from a modern view-point. Excellent illustrations accompany the discussion, which is amplified by good problems and valuable exercises. While modern developments are taken into account everywhere, one feels that the treatment in some chapters is too cursory to be effective. Particularly the section on optics should be enlarged. The book seems particularly well adapted for use in a general science course.

If there is enough time available—and we believe there should be—then the method used by Millikan and Roller should be admirably suited to create more interest on the part of the student and teacher in the logical development of physical thought. To break the trend of abstract reasoning Millikan and Roller insert some chapters on historical developments. We found that students prefer this type of presentation, and we believe that a book of this caliber should be extremely useful in the teaching of both science and engineering students. However, we note with regret that in a book which is the first part of a two-year physics course no mention is made in the section on mechanics of the importance of *reference systems.* This material would help greatly in clarifying such concepts as centrifugal force, and would also be of advantage in the under-

standing of relativity later on. We also feel that in the part on heat some space should be devoted to the clarification of the concept of entropy, and in this way problems in thermodynamics could be handled with better understanding, and the connection of thermodynamics with the kinetic theory of matter would be made clearer.

The question whether calculus should be used in an elementary physics course is answered by different teachers in different ways according to the nature of the course. A two-year book, like the one of Millikan and Roller, and the more advanced text, like Bayley and Bidwell, have in this respect an advantage over texts which have to struggle with the derivation of physical concepts by circumventing calculus.

Nothing perhaps brings out more clearly the difference in material as the second-year books, which introduce the student to the different branches of physics in detail. Erickson's well-known text on mechanics is entirely elementary, so that it could be well used by a beginner. The books of Timoshenko and Osgood will require a broader background. Timoshenko's book (one of the few books to be recommended to the almost extinct species of student who studies independently), "Engineering Mechanics," is written for engineering students, but it will certainly be extremely useful in any intermediate course in mechanics. The large number of problems will help a great deal to understand the principles of mechanics and their application, and will be useful for any physics student who wants to gain a real working knowledge of mechanics. Osgood's book is of an entirely different character. In the preface Professor Osgood states that this book might be used in "a first course in mechanics given for sophomores," but where, oh, where is there a sophomore who has enough background to follow Osgood from the simplest concepts of mechanics to Hamiltonian dynamics? In most schools this book will serve well in a beginning graduate course. It is interesting in this connection to compare the training we offer in mechanics with that obtained in the English schools. A. S. Ramsey's book on "Hydrostatics" is a text-book for the use of first-year students in the universities and for the higher divisions in secondary schools. While the book is truly elementary in character (the problems are to be recommended to every physics teacher), there will hardly be any first-year students in our universities with enough training to use this book. Again it will be useful as a text in intermediate physics, especially in connection with Ramsey's other text on dynamics.

The subject of acoustics is treated only too briefly in most physics courses. A. T. Jones's book on "Sound" should appeal not only to the beginning physicist, but is simple enough to be used by a student of music who has had elementary physics. McLachlan in his new "Acoustics" stresses the applications of modern acoustical development in communication, broadcasting and transcribing music. He also gives an excellent introduction to the modern ideas about speech, and the book will be useful as a cross-reference in an elementary course in acoustics.

Edser's intermediate text on "Heat" has been somewhat enlarged and brought up to date. As such it will keep its place as a favorite with teachers and students.

Fermi's "Thermodynamics" is an elementary introduction which also gives some modern developments, but is rather condensed. While useful for an introductory course in thermodynamics, it needs a great deal of amplification on the part of the instructor to make the condensed treatment of value to the student. The problems are well chosen and interesting.

It is always a problem where to treat such subjects as capillarity, viscosity and diffusion properly. This gap is supposed to be filled by the text of F. C. Champion and Davy's "Properties of Matter." Modern developments are treated, and especially the chapters on capillarity should be useful. It contains, besides, such varied subjects as gravitation, elasticity, compressibility, seismic waves, method of determining Planck's constant, etc. While this variety may be useful for the book as a reference work, it is a handicap to use it as a text in a course.

As usual there are a large number of texts on electricity. For the beginner Ramsey's "Electricity and Magnetism" should be an excellent introduction to the more advanced text to be used in graduate courses. Hadley's book on "Electricity and Magnetism" is remarkable for the historical development, treated extremely carefully, and the good foundation it gives on the level of *high-school physics*. This illustrates again how much more training is required from the high-school student abroad as compared with the meager training we give in this country in high-school physics. The texts of Hirst and of Vigoureux and Webb are useful in the laboratory. It is somewhat startling to see that in Hirst's book, "Electricity and Magnetics," electrostatics is relegated to the very end of the book, which does not seem to be justified in view of the modern applications of electrostatics methods. Particularly useful are N. C. Page's "Lessons and Problems in Electricity." The material is not only well arranged, but the selection of problems and mathematical developments are such that both physics students and engineering students profit a great deal by its study.

Filon and Cooker published some years ago the standard work on photoelasticity. This book is used widely by engineers and physicists in industry for the

investigation of strength of materials. There has been, however, a great need for a book describing in simple language the elements of photoelastic measurements, and this gap seems to be filled by Filon's "A Manual of Photoelasticity for Engineers." It gives first a short introduction of the physical fundamentals of photoelastic methods, and then applies this knowledge to the treatment of instruments and measurements. The great productivity in the field of general physics texts and of many specialized advanced texts is of course stimulated by the interest in modern physics and physical research in this country. Still there exists a great gap which has not yet been filled between the introductory text and the specialized treatise. Any physicist who has occasion to discuss physical problems with chemists, biologists or engineers is often confronted with the following plea: The Germans have Kohlrausch's "Practical Physics" or Riecke's two-volume text on physics; physico-chemists, in this country, have the excellent work of Hugh C. Taylor and his collaborators; physiologists can refer to Bayliss's standard text, but there is no physics text, in the English language, of this character, a book that makes it possible for scientists working in other fields to obtain an adequate knowledge in physics beyond the elementary text and without going to specialized handbooks. May we express the hope that the American Physical Society and the Association of American Physics Teachers will soon find means to prepare a text-book in physics to meet this demand!

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SPECIAL ARTICLES

HETEROLOGOUS TRANSPLANTATION OF HUMAN AND OTHER MAMMALIAN TUMORS

Various claims to the successful grafting of human cancers to lower species of animals have not been substantiated by repetition, and at the present time the view generally held by workers in the field of cancer research is that such transplantation is impossible. In fact, the heterologous transplantation of tumors between even closely related species has met with little success. Murphy[1] was able to grow the Jensen rat sarcoma in developing chick embryos, and the successful transplantation of mouse carcinomata to rats has been independently reported by Shirai,[2] Putnocky[3] and others.

The transplantation of a uterine carcinoma of the rabbit into the anterior chamber of the eyes of other rabbits has been reported.[4] The ease with which the initial transplantation was made, in contrast to the complete failure of other modes of inoculation, suggested that this method might be used successfully for heterologous transplantation. The success of early attempts was recorded in the paper just mentioned. However, in view of the obvious importance of heterologous transplantation to both biology and cancer research, a preliminary report of the successful growth of rabbit tumors in other species of animals through serial generations and of a human cancer in rabbits seemed desirable.

Two rabbit tumors, an adenocarcinoma of the uterus and an adenocarcinoma of the breast have been successfully transplanted into the eye of the guinea pig. The methods employed were described in detail in the paper referred to above.[4] Transplantations were always made under anesthesia. The uterine tumor was taken from the sixth rabbit generation and so far has been transplanted serially through three generations in the guinea pig. The breast tumor was transferred to the guinea pig after two generations in the rabbit and is now growing in the second guinea pig generation.

Growth of the tumor in the foreign species presented the same characteristics as in the natural host. Microscopic examination of heterologous transplants show that so far the histological character of the tumors has remained unchanged. The cells of the transplant are descendants of the original neoplasm and not derivatives of the guinea pig.

The ultimate fate of the heteroplastic tumors is uncertain. At the present time, progressive growth has been observed in guinea pigs bearing the breast tumor for more than one hundred days and in pigs with transplants from the uterine tumor for as long as three months. So far, the tumors have not metastasized, but in no instance have the pigs been held for a period of time as long as that required for the development of metastases from homologous transplants.

A successful transplantation of a human scirrhus cancer of the breast has also been made, and slow but progressive growth has continued for more than eighty days.[5] In this instance, the transplantations were made during the summer months at a time when only a small percentage of homologous grafts are successful and growth rates are much reduced. Moreover, two hours

[1] J. B. Murphy, *Jour. Exper. Med.*, 17: 482, 1913.
[2] Y. Shirai, *Japan. Med. World*, 1: 14, 1921.
[3] J. Putnocky, *Ztschr. für Krebsforsch.*, 32: 520, 1930.
[4] H. S. N. Greene and J. A. Saxton, Jr., *Jour. Exper. Med.*, 67: 691, 1938.

[5] This tumor was obtained through the kindness of Dr. R. A. Moore and Dr. W. A. Cooper, of the Cornell University Medical College.

elapsed between biopsy and transplantation of the tissue.

Despite these conditions, the human tumor has grown in seven of the twelve rabbits used. Growth first became apparent toward the end of the third week when the rough edges of the fragments became rounded and their color changed to a pinkish-yellow in contrast to the dull white of pieces that failed to grow. The extension of blood vessels from the iris into the transplant occurred in four of the animals between the thirty-fifth and fortieth days. Vascularization has not occurred to date in three of the animals in which primary growth was observed, but notwithstanding the fragments have continued to increase in size.

The growth rate increased following vascularization, and at the present time the transplants are approximately five times their original size. In two instances the pieces are attached to the cornea, which has apparently been invaded by tumor cells and extension to the outside is imminent. In the remaining instances, the transplants are attached to the iris, and irregular projections of growth may be observed in many planes.

In so far as heterologous transplantation from rabbit to guinea pig is concerned, it has been definitely established that the anterior chamber of the eye affords a means of transplantation of the tissues of one species into the body of another where apparently they may be continued indefinitely. The human cancer has not been carried as far, but since the behavior of the grafts conforms in all respects with those of rabbit tumors in guinea pigs, it seems highly probable that human tissues can also be maintained indefinitely in the foreign host.

The serial transplantation and growth of the tissues of a mature animal of one species in an animal of another species opens up a number of interesting problems. Among them is the question of the specific nature of the tissue ultimately grown in the foreign host. This and other problems are under investigation. Detailed results of this series of experiments will be reported elsewhere.

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REDUCED BLOOD COAGULATION TIME BY INJECTION OF STEROL EXTRACT OF LIVER

DURING a study of sterols extracted from the liver, a more rapid clotting of the blood was noticed after one of the lipid fractions was injected subcutaneously into a hypophysectomized-depancreatized dog. A preliminary investigation therefore has been made of the effect of this fraction in reducing the clotting time in animals with a hemorrhagic tendency from ligation of the bile duct and from a vitamin K deficiency. Dam[1] and Almquist and Stockstad[2] have described the production of a generalized hemorrhagic tendency in chicks fed a diet deficient in vitamin K and were able to prevent the bleeding tendency by the feeding or injection of extracts derived from alfalfa, hog liver fat, green vegetables and other sources. The reduced prothrombin of rats after bile duct ligation has been elevated by feeding vitamin K, in large amounts or with the addition of bile.[3] Highly potent concentrates of vitamin K which can be injected parenterally have been obtained by Almquist[4] and by Dam and Glavind.[5] They describe the vitamin as a non-sterol, unsaponifiable lipid. Osterberg[6] also described it as a non-sterol, which was alkali labile and fairly heat-stable.

The substance we employed in this study is a sterol which is fairly stable to alkali and heat. It has been obtained from the livers of dog, lamb and pig by the following method of extraction. One kilogram of ground liver from a freshly slaughtered animal was extracted at 50° C. with 2 liters of 95 per cent. alcohol which was acidified with 0.3 cc of concentrated HCl and then re-extracted with 2 liters of 95 per cent. alcohol. The combined filtrates were saponified for 1 hours at 45° C with 50 grams of $Ba(OH)_2$ and 8 grams of NaOH, then held at 0° C for 4 hours before filtering at room temperature. After concentrating the clear dark amber solution to ½ volume with reduced pressure at 40° C it was vigorously shaken with 500 cc of petroleum ether, the alcohol phase was diluted with an equal volume of water and shaken again. Two additional extractions were made with 200 cc portions of petroleum ether. Evaporation of the ether from the combined extracts left about 700 mg of a yellow crystalline material, soluble in about 10 cc of sesame oil at 38° C. Small amounts of this impure material gave positive Salkowski and Lieberman Burchard reactions but negative Rosenheim and Pettenkoffer tests. Only a few milligrams of precipitate could be obtained by digitonin treatment of 500 mgm of the crude material.

The sterol fractions have been taken up in sesame oil for subcutaneous injection into normal and jaundiced rats and into vitamin K deficient chicks. Dogs have been used for the intravenous injections of the extract, suspended in an emulsion with lecithin in normal saline. For the determination of clotting time blood was drawn in the rat by syringe from the heart

[1] H. Dam, *Nature*, 133: 909, 1934.

[2] H. J. Almquist and E. L. R. Stockstad, *Jour. Biol. Chem.*, 111: 105, 1935.

[3] J. D. Greaves and C. L. A. Schmidt, *Proc. Soc. Exp. Biol. and Med.*, 37: 43, 1937.

[4] H. J. Almquist, *Jour. Biol. Chem.*, 120: 635, 1937.

[5] H. Dam and J. Glavind, *The Lancet*, 1: 707, March 1937; H. Dam, J. Glavind, L. Lewis and E. Tage-Hansen, *Skand. Arch. Physiol.*, 79: 121, 1938.

[6] A. E. Osterberg, *Proc. Staff Meet., Mayo Clinic*, 13: 72, 1938.

r from the femoral vein under light ether anesthesia, n the chick directly from a wing vein into a fine glass apillary tube and in the dog by cardiac or venous uncture. Coagulation time was determined by breaking the capillary tube and confirmed with a drop of lood on a glass plate. Determinations were made on ndividual animals before injection and at 6 and 24 ours afterward, then daily for several days.

Five to 7 days after bile duct ligation the average lotting time in 30 old male rats weighing 300 grams r more was elevated to 10 minutes. Young male rats eighing 100 to 200 gms did not develop this hemorrhagic deficiency to the same extent, the average clotting me in 30 animals being only 3 minutes in from 6 to 2 days after the operation. Average results after inection of 60 and 70 mgm of the crude sterol extract nd 15 mgm of the fraction which was not precipitated y digitonin are shown in the table. Reduction of the lotting time to a normal level occurred within 6 hours nd persisted for 24 to 48 hours. Pure cholesterol and holesterol recrystalized after digitonin precipitation xerted little if any effect as compared to the sesame il controls. In smaller amounts, 14 to 20 mgms, the rude extract was less effective. Female rats were ound to develop the hemorrhagic tendency after bile uct ligation more slowly than the males, showing an verage clotting time of 3½ minutes in 6 to 8 days postperative and 9 minutes in 14 to 22 days. Their reponse to injection of the various extracts was essenially negative.

TABLE 1

FFECT OF INJECTED LIVER EXTRACTS ON THE BLOOD CLOTTING TIME (IN MINUTES) OF JAUNDICED RATS AND VITAMIN K DEFICIENT CHICKS

Material injected	Mgm injected	Subject	No. averaged	Hours after injection 0	6	24
ig liver extr.	60	Old rat	5	7	2	3
on-dig. ppt. fract.	15	" "	2	6	2.5	
holesterol	10–25	" "	3	13	8	12
ig liver extr.	70	Young rat	4	4	2.3	3
holesterol	25	" "	3	2.7	2.6	3
amb liver extr.	20	Chick	8	20	8	3.5
ig liver extr.	24–60	"	6	14	5	4
on-dig. ppt. fract.	15	"	5	15	8	5
ig. ppt. fract.		"	2	14	3	6
holesterol	25	"	8	7	6	4

Subcutaneous injection also was effective in chicks n a vitamin K deficient diet. The average clotting me was 17 minutes for 36 chicks when 14 to 18 days ld. After injection of 20 to 60 mgm of the active xtract or 15 mgm of the non-digitonin precipitable raction this was markedly reduced within 6 hours and as decreased further at 24 hours. The effect persisted for several days in some chicks, in others the lotting time increased again after the third day. The mall amount of material precipitated by digitonin reatment was very active when tried in 2 chicks, hereas pure cholesterol in 25 mgm doses caused only a slight diminution in the clotting time. We are indebted to Dr. Robert Moore, of the Department of Pathology, for determining that the average prothrombin time was lowered from 10 min. in the controls to 3 min. in the chicks injected with the liver extract.

Normal male rats in a few experiments showed about a 50 per cent. fall in clotting time after administering 15 mgm of the crude extract subcutaneously. In three female dogs, one of which was jaundiced from bile duct ligation, a single intravenous injection of 10 or 15 mgm in lecithin emulsion produced a similar reaction. The clotting time remained at this low level for 48 hours and then gradually increased again. The effect of the intravenous injection was not directly on the blood, since the addition of the extract to freshly drawn dog blood *in vitro* tended to prolong rather than to reduce the coagulation time.

These results indicate that the liver contains a sterol which is active in reducing the blood clotting time of normal and jaundiced dogs and rats. A single intravenous or subcutaneous injection maintains this effect for several days. The extract is similar in action to vitamin K in that it will correct the hemorrhagic tendency in vitamin K deficient chicks when injected subcutaneously. Its sterol nature and resistance to alkali differ from the properties described for vitamin K.[7]

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THE BLOOD VESSELS IN THE CENTRAL NERVOUS SYSTEM OF THE KANGAROO

WISLOCKI and Campbell[1] have recently demonstrated that in the opossum the tissue of the central nervous system is not vascularized by a continuous spongy reticulum of capillaries such as exists in the brains of other mammals, so far as known. Instead, it is supplied by vessels which run in very closely associated pairs, arterial and venous, each member of the pair branching when the other does, and the branches ending as simple loops without any anastomosis. Such an arrangement had formerly been known only in certain lizards (Schöbl[2] and Sterzi[3]) and, in much simpler form, in tailed amphibians (Schöbl,[4] Sterzi[3] and Craigie).[5]

The phylogenetic relationship of the non-anastomosing capillary loops and the freely anastomosing capil-

[7] See references 4, 5 and 6.

[1] G. B. Wislocki and A. C. P. Campbell, *Anat. Rec.*, 67: 177–191, 1937.

[2] J. Schöbl, *Arch. f. mikr. Anat.*, 15: 60–64, 1878.

[3] G. Sterzi, *Anat. Hefte*, I Abt., 24: 1–364, 1904.

[4] J. Schöbl, *Arch. f. mikr. Anat.*, 20: 87–92, 1882.

[5] E. Horne Craigie, *Proc. Amer. Phil. Soc.*, 78: 615–649, 1938.

lary network is a problem of much interest, and the discovery of Wislocki and Campbell at once raises the question whether or not the condition in the opossum is one characteristic of marsupials in general and of monotremes. It is to be hoped that the matter will soon be investigated where such animals are freely available.

Meanwhile it has been possible to examine sections of the cerebellar cortex and of the cervical region of the spinal cord of a specimen of *Macropus bennetti.* The specimen had been in formalin for some years, so that injection methods were not applicable, but a variety of stains were tried, of which that of Perdrau yielded

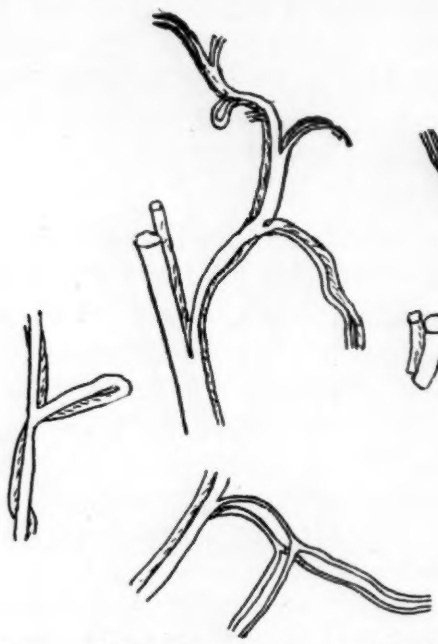

FIG. 1. Drawings of vessels in a section 150 micra thick of the spinal cord of *Macropus bennetti,* stained by the method of Perdrau.

the most useful, though not very good, preparations. These show clearly that the disposition of the vessels in the tissues examined is largely, and probably entirely, the same as that in the opossum. The vessels run in closely associated pairs, the one member usually noticeably larger than the other. Each member of a pair branches when the other does. The branches end in simple loops and there is no evidence of anastomosis. Thus it appears probable that the central nervous system of the kangaroo is like that of the opossum in being vascularized entirely by much branched, but strictly non-anastomosing, looped blood vessels. The fact that the two marsupials examined, representing different superfamilies and different geographical areas, both show this character suggests the likelihood that it is a feature of the Metatheria in general.

Scharrer[6] has emphasized the end-arterial character of the arteries entering the brain-substance of the opossum, but has pointed out that the branches of adjacent pairs of vessels interlace in such a fashion that any given mass of tissue is supplied by branches from several of them. The close association between the two members of a pair throughout their length does not appear to have been discussed, however. Mossman[7] has shown that in the placenta of the rabbit the maternal and foetal vessels run parallel to each other in opposite directions, so that as fetal blood runs through the placental capillaries it comes into association with maternal blood of increasing purity and may be in approximate equilibrium with the arterial blood of the mother when it reaches the umbilical vein. It seems possible that a somewhat analogous situation exists in the central nervous system which is vascularized by capillary loops. A spongy reticulum permits a more or less free distribution of blood in all directions through the tissues, but when the supply is entirely by closed, non-anastomosing loops, the venous limb of each loop would tend to carry less oxygen and nutriment and more waste products than the arterial limb. If the limbs were spread widely apart, the tissue immediately surrounding each venous limb would thus be supplied with blood poorer than that supplying the tissue surrounding each arterial limb. The two limbs being so closely associated as they are, however, the blood flowing along the venous limb and tending to decrease in purity is associated with blood of increasingly arterial character in the arterial limb. Thus a relatively uniform condition of the blood throughout the capillary loop may be maintained and every part of the tissue through which the loop passes is more likely to have an adequate supply. Such an arrangement would be of obvious value in the salamander brain, where the loops are simple and there is no extensive interlacing of branches, and would doubtless be equally important in the nervous system of the warm-blooded animal, with its greater metabolic requirements.

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